

Claims

1. A thermoplastic cross-linked polymer compound with thermally reversible urethane crosslinkages comprising the following essential components a) to d):
- 5 a) a thermoplastic polymer component with saturated molecular main chain;
b) a component containing isocyanate group(s), either attached to the polymer chain or being present in mobile form in the polymer matrix;
c) a component containing hydroxyl group(s) either attached to the polymer chain or being present in mobile form in the polymer matrix;
10 d) a catalyst package promoting the reversible formation and thermal dissociation of urethane bonds,
characterized in that at least one of the components b) and c) is attached to the polymer chain and at least one of the additives present in the compound is multi-functional, playing a role in more than one, functionally independent
15 processes.
2. The compound according to claim 1 wherein the component b) containing the isocyanate group(s) is attached to the polymer chain by copolymerisation, grafting or by polymer-analog reaction.
3. The compound according to any of claims 1 and 2 wherein the
20 component c) contains phenolic, aliphatic or cycloaliphatic hydroxyl groups.
4. The compound according to claim 3 wherein the component c) contains phenolic hydroxyl groups.
5. The compound according to any of claims 1 to 4 wherein the component c) containing the hydroxyl group(s) is attached to the polymer chain
25 by copolymerisation, grafting or by polymer-analog reaction.
6. The compound according to claim 1 wherein when the isocyanate group is attached to the main chain, the hydroxyl component exhibits an average functionality of at least 2.

7. The compound according to claims 1 or 6 wherein when the hydroxyl component is attached to the main chain, the isocyanate component exhibits an average functionality of at least 2.

8. The compound according to any of claims 6 and 7 wherein when both
5 components are attached to the main chain, the functionalized polymer molecules themselves exhibit an average functionality of at least 2.

9. The compound according to any of claims 1 to 8 wherein the thermoplastic polymer is a polyolefin.

10. The compound according to claim 9 wherein the isocyanate and/or
10 the hydroxyl groups are attached to the main chain by radical grafting reaction so that essentially no irreversible C-C crosslink points are formed, or at least their presence does not cause gelation after the thermal dissociation of the thermally reversible urethane crosslink points.

11. The compound according to any of claims 9 and 10 wherein the
15 isocyanate component is chemically attached to the main chain of the thermoplastic component and the hydroxyl group is present in a low molecular mobile polyphenol or in a prepolymer/oligomer.

12. The compound according to any of claims 9 and 10 wherein the
hydroxyl group is attached to the main chain of the thermoplastic component
20 and the isocyanate component is present in a low molecular mobile polyisocyanate or in a prepolymer/oligomer.

13. The compound according to any of claims 9 and 10 wherein both the isocyanate and the hydroxyl groups are chemically attached to the main chain of the thermoplastic component.

25 14. The compound according to claim 9 wherein the hydroxyl group is present in a polyphenol, which simultaneously acts as an antioxidant and/or thermal stabilizer, optionally grafted to the polymer main chain.

15. The compound according to claim 9 wherein the thermoplastic polymer is ethylene, propylene or other α -olefin homo- or copolymer, or a blend
30 of such homo- or copolymers.

16. The compound according to any of claims 1 to 15 wherein the catalyst package consists of a non-volatile ($T_b > 150\text{ }^{\circ}\text{C}$) tertiary amine and a transition metal salt of a linear or branched chain mono- or polybasic carboxylic acid with at least 10 carbon atoms.

5 17. The compound according to claim 16 wherein the metal salt is zinc stearate.

18. The compound according to claim 16 wherein the non-volatile amine compound is a hindered amine light stabilizer.

10 19. The compound according to any of claims 1 to 8 further containing a processing aid consisting of a layered silicate or a mixture of layered silicates, promoting the uniform distribution of the additives in the polymer matrix and preventing their macroscopic phase separation.

15 20. The compound according to claim 19 wherein the layered silicates are selected from consisting of organophilic montmorillonite, bentonite, fluoro-hectorite, clay, talc or mica.

21. A process for preparing a thermoplastic compound according to any of claims 19 to 20 consisting of the following steps:

- 20 a) preparing a first additive package containing the monomer(s) of one of the components b) and c) to be grafted and the radical source and a processing aid, by mixing the processing aid first with the radical source, then with other component(s)
- 25 b) preparing a second additive package containing the other urethane forming component not present in the first additive package, the processing aid, the urethane catalysts and, if both the hydroxyl and the isocyanate components are to be grafted, the radical source, such as peroxide, by mixing first the processing aid with the solid components, then with other component(s),
- c) melting the thermoplastic polymer,
- d) mixing the first additive package with the molten polymer at a temperature where the grafting reaction is complete within a few minutes,

e) mixing the second additive package with the molten polymer obtained in step d) at a temperature where the urethane formation reaction is complete within a few minutes,

f) followed by proper shaping (e.g. extrusion/granulation, injection, etc.) the compound and cooling down.

22. The process according to claim 21 wherein in steps a) and/or b) at least one organic solvent is used to combine the processing aid and the additives if all components are solid initially.

23. A continuous process according to any of claims 21 and 22 wherein the mixing process is performed in a multi-port extruder and the additive packages are added to the system at subsequent feed-ports.

24. Plastic semi-finished goods and products made of thermoplastic compounds according to any of claims 1 to 20.

~~25~~ 25 Plastic semi-finished goods and products made of thermoplastic compounds prepared by the methods according to any of claims 21 to 23.